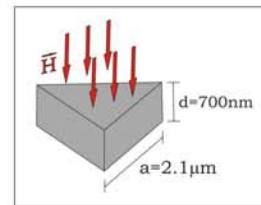


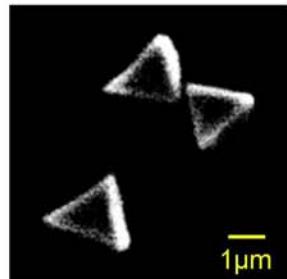
Novel Vortex States in a 3D Shape-Controlled Mesoscopic Superconductor

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- Electrochemically grown 3D superconducting Pb meso-crystals
- Vortex behavior dominated by shape and size effects
- μ -Hall probe magnetometry: transition from type-I to type-II behavior
- novel vortex phases: giant vortices, coexisting Abrikosov and multiquanta vortices



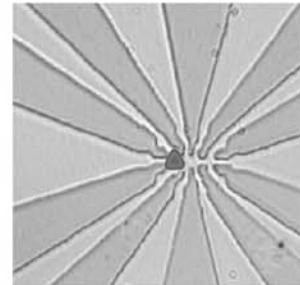
Vortex states in μ -sized Pb crystals



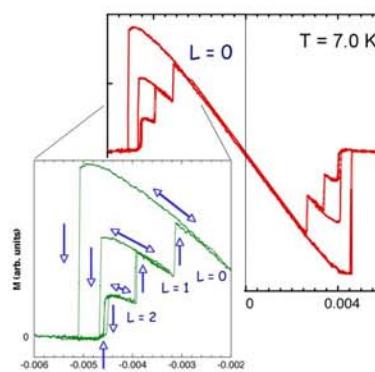
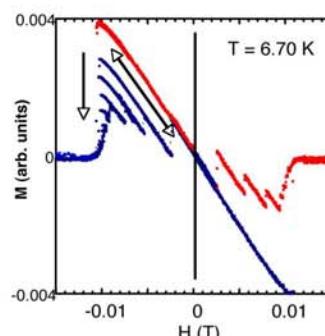
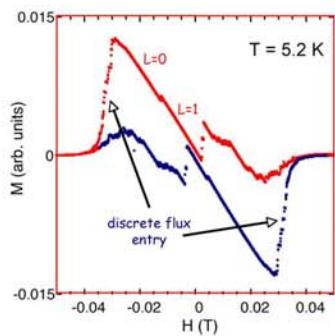
Parameters of clean Pb:

Type I in bulk
 $H_c = 80$ mT; $T_c = 7.20$ K;
 $\lambda_L = 37$ nm; $\xi_0 = 83$ nm
 $\kappa = 0.45$

Triangular Pb crystals
thickness $\sim 1/3$ of width
 $L \sim 2$ μ m, with faceted sides



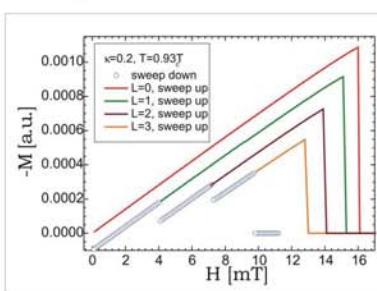
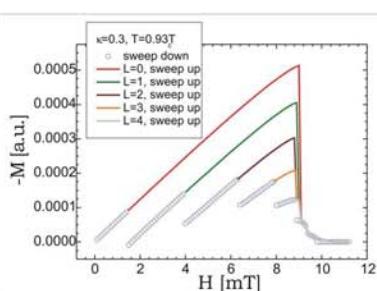
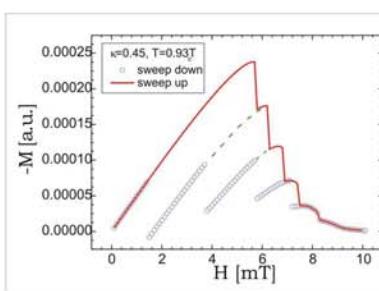
Ballistic 2DEG μ -Hall probe
1 μ m \times 1 μ m effective area
10 mA measurement current



“back-track” reveals stability range of L-states

$T < 6.7$ K: high L-states stable in high fields; type -II

$T > 6.7$ K: high L-states unstable in High fields: type-I

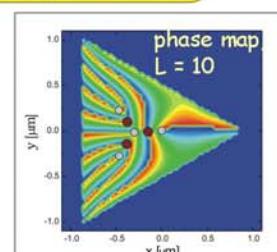


3D Ginzburg-Landau theory

“Meissner overhang” for $T > 6.7$ K transition to type-I

Future exploration of vortices in confined geometries

- Novel vortex phases: coexisting Abrikosov and multiquanta vortices
- Stability of states of vorticity L as function of size, shape, κ , and T
- Orientation dependence, surface effects
- Nucleation of vortices in different crystal shapes
- Enhanced pinning at nano-vertices



- giant vortex, vorticity = 2
- Abrikosov vortices

